ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)

ZWEIBRUECKEN MILITARY COMMUNITY

WEST GERMANY

REVISED EXECUTIVE SUMMARY

AUGUST, 1986

PREPARED FOR

DEPARTMENT OF THE ARMY

EUROPEAN DIVISION, CORPS OF ENGINEERS

CONTRACT NO. DACA 90-81-C-0096

A & E INTERNATIONAL/NEWCOMB & BOYD CONSULTING ENGINEERS

A JOINT VENTURE

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EEAP - ZWEIBRUECKEN

REVISED EXECUTIVE SUMMARY - CONTENTS

1.0 INTRODUCTION AND SUMMARY

1.1 Introduction:

This document is the Executive Summary of the Phase II Energy Report for the Energy Engineering Analysis Program (EEAP) for the Zweibruecken, West Germany Military Community. The purpose of this document is to present analysis of potential energy conservation projects at each of the sites. The EEAP provides engineering studies of Army facilities to identify and analyze facility energy conservation projects. This program has been completed, is being performed, or is planned for all Army facilities worldwide. This project provides for completion of that program for Zweibruecken Military Community. Work is being performed under the direction of the European Division of the U.S. Army Corp of Engineers under Contract No. DACA90-81-C-0096. The study is being performed by A & E International/Newcomb & Boyd, Consulting Engineers, a joint venture, with home offices located in Atlanta, Georgia. Local engineering support for the project is being provided by Lahmeyer International, GMBH.

1.2 Zweibruecken Military Community

The U.S. Army military community activity, Zweibruecken, consists of a headquarters at Kreuzberg Kaserne in Zweibruecken and 7 other installations within the 1,750 square mile community area. Four of these facilities are ammo storage areas only. Another area is an inactive weather station. During Phase I of the EEAP in a meeting between Community, Corps of Engineers and A/E representatives, it was decided to limit the scope of the project to Kreuzberg Kaserne only. Refer to section 1.3.3 for a discussion of the selection of installations. Figure 1.1 shows the location of the installation surveyed.

1.2.1 Kreuzberg Kaserne (GY 702) - The headquarters of the Zweibruecken Military Community is located in Zweibruecken at Kreuzberg Kaserne. The Kaserne houses administrative, communications, and computer facilities. Troop billets, multifamily housing units, and community support facilities are sited at Kreuzberg. Warehouses, maintenance shops and the facilities engineering headquarters are located at this Kaserne also.

1.3 Scope:

1.3.1 EEAP Scope:

The objectives of the EEAP as stated in the project Schedule of Title 1 Services are:

"a. Develop a systematic plan of projects that will result in the reduction of energy consumption in compliance with the objectives set forth in the Army Facilities Energy Plan without decreasing the readiness posture of the Army.

b. Use and incorporate applicable data and results of related studies, past and current, as feasible.

c. Develop coordinated base wide energy systems plans for each military community.

d. Prepare Program Development Brochures (PDB's), DD Forms 1391 and supporting documentation for feasible energy conservation projects.

e. Include in the program studies all methods of energy conservation which are practical (in so

far as the state-of-the-art is reasonably firm) and economically feasible in accordance with guidance given.

f. List and prioritize all recommended energy conservation projects."

A complete copy of the Schedule of Services is included in the Data Report. EEAP project activity is divided into 4 increments:

1.3.1.1 Increment A:

Energy conservation projects involving modification and improvements to existing buildings are included under this increment. All projects will be evaluated according to Energy Conservation Investment Program (ECIP) criteria and ranked according to Savings to Investment Ratio (SIR). Planning and programming documents for recommended ECIP projects will be prepared.

1.3.1.2 Increment B:

This increment includes energy conservation projects for utilities and energy distribution systems. Computerized energy monitoring and control systems (EMCS) will also be evaluated under this increment. All projects will be economically evaluated using ECIP criteria and planning and programming documents will be prepared for recommended projects.

1.3.1.3 Increment F:

This increment includes recommendations for modifications and changes in system operations to conserve

energy. These recommendations are to fall within the Military Community's funding authority of $200,000 for alteration type work and $500,000 each for maintenance and repair work. Additional tasks under this increment include analysis of the energy requirements of planned facilities listed in the Military Community's Master Plan, recommendation for additional training of facilities engineer personnel, and a study of the replacement of expendable equipment with more energy efficient types. All energy conservation measures and projects from all increments are to be summarized and prioritized under this increment.

1.3.1.4 Increment G:

Projects whose costs exceed the local community's funding authority and have an SIR greater than 1 but an ESIR less than 1, qualify for inclusion under Increment G. These projects are those which are too costly for inclusion in Increment F and save dollars but not enough energy to qualify for ECIP funding under Increments A and B.

These projects would be funded from maintenance, repair (OMA) and minor construction projects (MMCA) funds.

1.3.2 EEAP Process:

An EEAP project is performed in three phases as follows:

1.3.2.1 Phase I:

The primary purpose of this phase is to gather energy related site data (written and verbal) and perform a field survey of the site to identify existing facility physical and operational conditions. The Preliminary Submittal occurs at the end of Phase I and documents the data gathered during Phase I. This information is contained in the Revised Data Report.

1.3.2.2 Phase II:

During this phase, the information obtained during Phase I is analyzed to identify energy conservation projects. Once those projects are identified, they are analyzed to project potential savings and cost which would occur if the projects were implemented. The savings and cost are analyzed using standardized economic procedures and then prioritized based that economic evaluation. The Interim Submittal is provided at the end of Phase II and documents the project selection and analysis process. The Interim Submittal consists of the Energy Report and other miscellaneous documents.

1.3.2.3 Phase III:

During this phase, funding documents (Forms 1391 and Program Development Brochures) are prepared for those projects identified in Phase II as having economic characteristics which satisfy the appropriate

criteria (ECIP). At the completion of Phase III, the Pre-final Submittal is made and includes all proposed funding documents. Government comments on the Pre-final Submittal are then incorporated in a Final Submittal.

1.3.3 Project Scope:

The work in this project includes both buildings and utility systems. Funding for the project is not sufficient to perform detailed survey and analysis of every single building in the community, therefore, two different survey procedures were applied. A detailed building survey aimed at collecting sufficient data to create a computer model of the building's energy use profile was performed on a limited number of representative buildings. The remaining buildings were surveyed in somewhat less detail to catalogue existing equipment and conditions and correlate the building with one of the buildings to be modeled by computer.

A "kick off" meeting was conducted in the community prior to the commencement of the Phase I field survey with representatives of the community, European Division Corps of Engineers, and the A/E in attendance. At this meeting the list of installations was reviewed and the installations listed in Figure 1.2 omitted from the survey. The building lists of the remaining installations were then reviewed. Buildings such as guard towers, unheated warehouses, and ammunition storage facilities were deleted from the survey due to low energy consumption and minimal opportunity for energy conservation. The list of buildings to be surveyed in detail for computer modeling was also finalized. Refer to Figure 1.3 for

the list of installations surveyed. Figure 1.4 contains a list of buildings surveyed with the buildings surveyed in detail noted.

In addition to buildings, utility systems at each site are included in the scope of the investigation. Utility systems included are boiler plants, electrical and thermal distribution, and exterior lighting.

1.4 Executive Summary Scope:

This report provides a summary of the energy and cost analysis leading to recommendation of proposed energy conservation projects documented in the Energy Report. The Energy Report's prime objective is to use the data gathered during site visits and field inspections to select, analyze savings, estimate cost and evaluate economic criteria for energy conservation opportunities. Section 2.0 of this report provides illustration of the existing energy situation at each site based on the available information provided by the Community. Energy conservation opportunities (ECOs) considered for selection are summarized in Section 3.0 of this report. These ECO's are derived from the Army Facilities Energy Plan, community suggestions, and experience on other projects. Section 4.0 of this Executive Summary briefly describes the various energy conservation projects developed as a result of our analysis. Three types of projects were identified including ECIP projects, energy conservation projects to be funded though the use of Form 4283's and Increment F projects. No projects meeting the qualifications for Increment G were identified. (See Section 1.3.1.4).

Section 5.0 of this Summary addresses the impact on energy consumption of implementing the various energy conservation project.

1.5 Phase II Methodology:

1.5.1 Objectives: The primary end product of EEAP Phase II is a consolidated list of architectural, mechanical, and electrical modification projects which will result in a reduction of energy consumption. The list includes estimated construction cost and energy saved for each project along with appropriate economic indicators (SIR) as dictated by ECIP criteria. The list is arranged in order of best (largest) SIR. From this list, Community and Corps of Engineers personnel will coordinate selection of projects for preparation of funding documents (1391, PDBs) and the time frame for execution of those projects. Funding documents will be prepared for those selected projects as a part of Phase III of the EEAP program.

1.5.2 Methodology: The Phase II analysis was accomplished using the following six basic steps:

Step 1 - Prepare a master list of energy conservation opportunities (ECO) for buildings and utility systems based on Phase I experience and the list of ECOs included in the Army Facilities Energy Plan.

Step 2 - For each building and utility system at each installation, select those ECOs from the master list which are applicable according to the Phase I survey data.

Step 3 - Calculate energy savings for each ECO/building/system combination. The calculation process uses a combination of computerized and manual methods. Manual methods are used where the ECOs are simple and are not affected by other ECOs. Computer analysis is used for building ECOs where many interrelated factors affect the results. The computer analysis consists of a base-line and modified analysis. The base-line run is based on existing conditions and operations. Subsequent runs simulate performance after the energy conservation project under study is implemented. The difference between those runs are the savings estimated for that ECO.

Step 4 - Calculate the cost to implement each ECO selected for each building. General unit cost have been developed from manufacturer's quotes and contracting experience provided by Lameyer International. Those unit costs are multiplied times the quantity of occurrences in a building or system to compute the total installation cost. All costs in the Phase II analysis are based on FY84 prices. After projects are selected and scheduled following Phase II, the cost will be escalated and updated to the time at which the project is finally scheduled.

Step 5 - Based on the savings and cost identified in Steps 3 and 4, economic analysis as defined in ECIP criteria is performed. Economic parameters include Total Discounted Savings, and SIR. These are summarized in a table and listed in order based on SIR.

Step 6 - A suggested packaging scheme for combining individual ECOs for individual buildings into projects is prepared. The packaging could be based on a building (i.e. all work in Building 4036) or type (i.e. all roof insulation on pitched roofs), or, most likely, some combination of buildings affected, type work, and energy savings (SIR).

1.6 Phase III Preparation:

As previously stated, Phase III of the EEAP program consists of preparation of funding documents (Form 1391 and Project Development Brochures). These documents will be prepared based on the government comments returned on this report submittal. Prior to beginning work on Phase III, it is requested that the latest criteria for preparation of these programming documents be furnished. Criteria furnished at the beginning of this project may have changed and the latest version should be used to avoid unnecessary modifications and changes after the Phase III submittal.

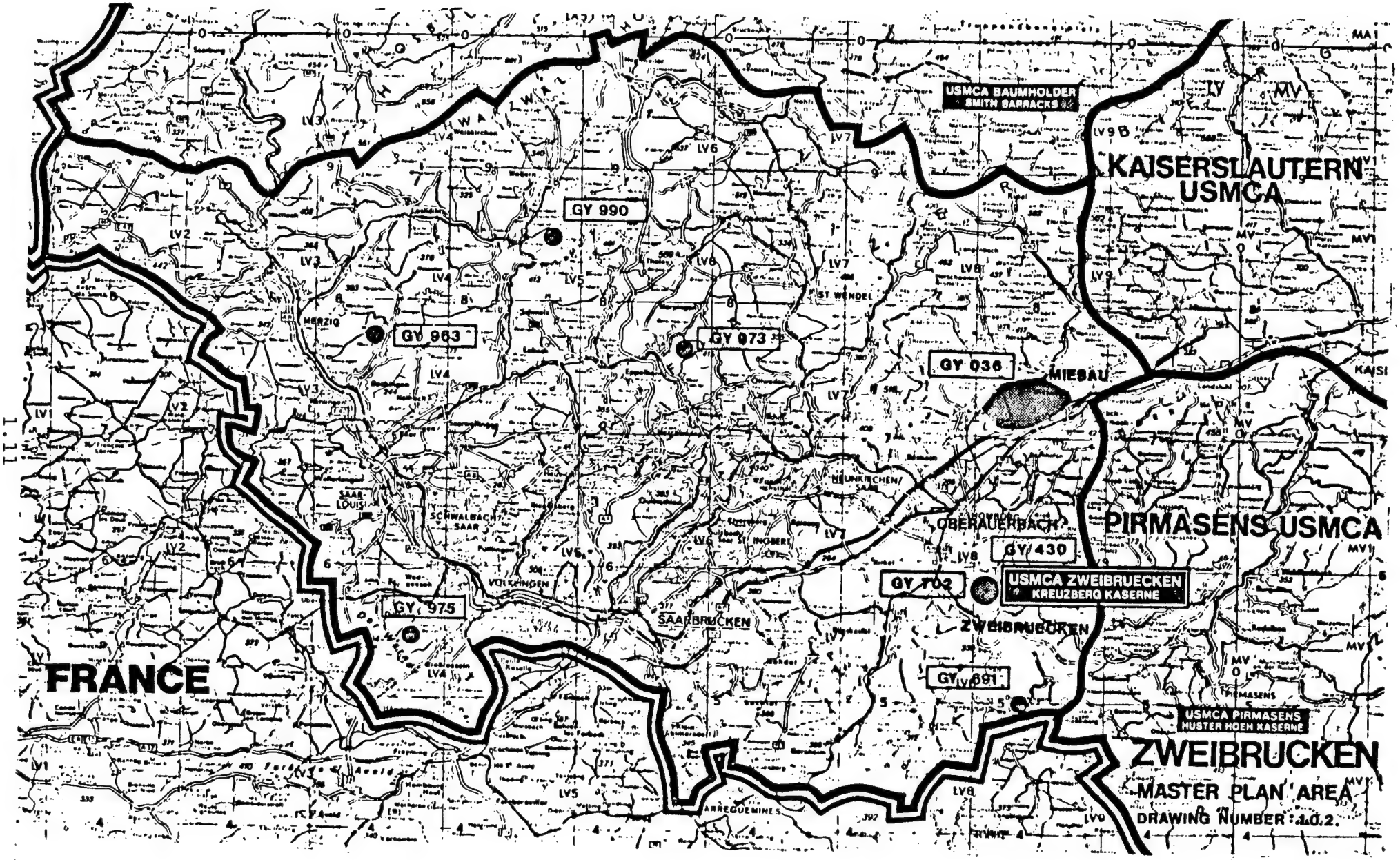

USMCA BAUMHOLDER
SMITH BARRACKS
KAISERSLAUTERN
USMCA
GY 990
GY 963
GY 973
GY 036
MIESAU
PIRMASENS USMCA
GY 430
GY 702
USMCA ZWEIBRUECKEN
KREUZBERG KASERNE
GY 975
GY 891
FRANCE
USMCA PIRMASENS
HUSTER HOEM KASERNE
ZWEIBRUCKEN
MASTER PLAN AREA
DRAWING NUMBER: 1.0.2.

FIGURE 1.1

Figure 1.2 ZWEIBRUECKEN COMMUNITY INSTALLATIONS OMITTED FROM SURVEY

GY 306 Miesau Ammo Depot - Previously surveyed by another A/E firm under separate contract.

GY 430 Oberauerbach Missile Station - The current facility usage is to be discontinued and the facility renovated in the future.

GY 691 Dietrichingen Recreation Facility - Little or no energy consumption.

GY 963 Haustadt Ammo Storage - Ammunition storage only.

GY 973 Urexweiler Ammo Storage - Ammunition storage only.

GY 975 Differten Ammo Storage - Ammunition storage only.

GY 990 Bueschfeld Ammo Storage - Ammunition storage only.

FIGURE 1.3 - INSTALLATIONS SURVEYED IN ZWEIBRUCKEN MILITARY COMMUNITY

INSTAL. NO.	NAME OF INSTALLATION	LOCATION	FACILITY NO.
GY 702	KREUZBERG KASERNE	ZWEIBRUCKEN	4000 - 4080 4200 - 4280

FIGURE 1.4 - BUILDINGS SURVEYED IN ZWEIBRUCKEN MILITARY COMMUNITY
KREUZBERG KASERNE, GY 702

BLDG NO	DESIGNATION	GROSS SQ FT	
4000	POST HQ BLDG	65,446	
4001	ADM GEN PURP	64,463	
4002	ADM GEN PURP	36,890	
4003	COM CENTER	6,489	DETAILED SURVEY BUILDING
	ADM GEN PURP	57,744	
4004	TAM BLDG	12,100	
	ADM GEN PURP	48,114	
4005	FIRE STATION	4,308	DETAILED SURVEY BUILDING
	SKILL CRT/AUTO	4,308	
4006	OPEN MESS NCO	20,756	DETAILED SURVEY BUILDING
4007	EXCH SVC OLS		DETAILED SURVEY BUILDING
	ADM GEN PURP	934	
	PO MAIN	2,824	
4008	ADP	18,590	DETAILED SURVEY BUILDING
4010	DENTAL CLINIC	4,637	DETAILED SURVEY BUILDING
	BANK	1,170	
	COMMISSARY	3,930	
	GOLF CLUB HOUSE	1,340	
4011	COMMISSARY	18,408	DETAILED SURVEY BUILDING
	ADM GEN PURP	9,600	
4014	GEN PURP WHSE	23,455	DETAILED SURVEY BUILDING
	FE STOREHOUSE	1,444	
	EXCH SVC STA	11,685	
4016	ADM GEN PURP	21,114	
4017	ADM GEN PURP	21,114	
4018	ADM GEN PURP	21,114	
4019	ENL PERS MESS	9,284	

FIGURE 1.4 CONT. - ZWEIBRUCKEN MILITARY COMMUNITY
KREUZBERG KASERNE, GY 702

BLDG NO	DESIGNATION	GROSS SQ FT	
4020	MOTOR REP SHOP	11,656	
4032	THEAT W/STAGE	9,324	
4033	EXCH CAFE	9,086	
4034	SKILL DEV CEN	2,720	
	EXCH MAIN RETL	25,947	
	EXCH SVC OLS	1,354	
	YOUTH CENTER	1,501	
	EM SERVICE CLUB	7,501	
	BOOK CLUB	991	
4036	ENL PERS MESS	22,465	DETAILED SURVEY BUILDING
	ENTR WORKSHOP	6,000	
	LIBRARY MAIN	5,000	
	EXCH BRANCH	5,500	
	EXCH SVC OLS	5,000	
	HEATING PLANT OIL	10,221	MECHANICAL SURVEY ONLY
4038	BOWLING CENYER	6,429	
4039	GYMNASIUM	16,231	DETAILED SURVEY BUILDING
4040	DEPN NUR SCH	1,589	
	EXCH SVC OLS	2,938	
4041	ADM GEN PURP	22,568	DETAILED SURVEY BUILDING
4042	GEN STOREHOUSE	2,995	
4043	ADM GEN PURP	22,568	
4044	GEN STOREHOUSE	2,944	
4045	EM BK W/O MS	22,568	
4046	EM BK W/O MS	22,568	
4047	GEN STOREHOUSE	4,600	
4048	EM BK W/O MS	22,568	

FIGURE 1.4 CONT. - ZWEIBRUCKEN MILITARY COMMUNITY
KREUZBERG KASERNE, GY 702

BLDG NO	DESIGNATION SQ FT	GROSS	
4049	EM BK W/O MS	22,568	
4050	EW BK W/O MS	22,568	DETAILED SURVEY BUILDING
4051	SEBQ	22,568	
4052	ADM GEN PURP	22,568	
4053	ADM GEN PURP	22,568	
4055	FE FAC	1,833	
4056	HEATING PL OIL	1,368	MECHANICAL SURVEY ONLY
4057	FE FAC	10,427	DETAILED SURVEY BUILDING
4057A	FE FAC	2,730	
4059	FE R&U SUPPLY		
4060	FE FAC	1,163	
4068	INDOOR RANGE		
4071	GEN STOREHOUSE	2,461	
4080	FRENCH OFFICE CLUB		
4200	FH FGN NCO	43,074	
4201	FH FGN NCO	43,074	DETAILED SURVEY BUILDING
4202	FH FGN CG & WO	26,563	
4203	FH FGN NCO	42,126	
4204	FH FGN NCO	36,032	
4205	FH FGN NCO	36,032	
4208	OPEN MESS OFF	14,393	
4209	DEPN GRADE SCH	11,861	
4211	FH FGN NCO	36,032	
4212	FH FGN NCO	26,032	
4213	FH FGN NCO	21,941	
4214	FH FGN NCO	11,815	

FIGURE 1.4 CONT. - ZWEIBRUCKEN MILITARY COMMUNITY
KREUZBERG KASERNE, GY 702

BLDG NO	DESIGNATION	GROSS SQ FT	
4215	FH FGN NCO	21,941	
4216	FH FGN NCO	21,941	
4217	FH FGN NCO	21,941	
4218	FH FGN NCO	21,941	DETAILED SURVEY BUILDING
4219	FH FGN NCO	11,815	
4221	FGN CG & WO	11,815	
4222	FGN CG & WO	11,815	
4223	FGN LC & MAJ	10,295	
4224	FGN LC & MAJ	10,295	
4225	FGN LC & MAJ	4,557	
4226	FGN COL	3,078	
4227	FGN LC & MAJ	4,557	
4228	FGN CG & WO	21,941	
4229	FGN CG & WO	21,941	DETAILED SURVEY BUILDING
4230	FH FGN CG & WO	21,941	
4231	FH FGN NCO	36,760	
4232	FH FGN NCO	36,877	
4233	HEATING PL OIL	4,649	MECHANICAL SURVEY ONLY
4242	POST CHAPEL	2,288	
4243	YOUTH CENTER	5,312	DETAILED SURVEY BUILDING
4246	DEPN GRADE SCH	33,376	DETAILED SURVEY BUILDING
4275	VILLA	3,655	
4276	G-4	13,864	
4277	B-6	26,888	
4278	B-10	21,759	
4279	FH FOR NCO	28,624	
4280	FH FOR NCO	7,576	

FIGURE 1.4 CONT. - ZWEIBRUCKEN MILITARY COMMUNITY
KREUZBERG KASERNE, GY 702

BLDG NO	DESIGNATION	GROSS SQ FT
S-4062	GEN STOREHOUSE	4,000
S-4064	VEHICLE STORAGE	1,935
S-4065	ROD GUN CLUB	7,818
S-4234	DEPN GRADE SCH	1,878
S-4235	DEPN GRADE SCH	9,713
S-4236	DEPN GRADE SCH	1,006
S-4237	DEPN GRADE SCH	1,006
S-4240	DEPN GRADE SCH	1,006

2.0 EXISTING ENERGY SITUATION

2.1 Background:

One of the requirements of the EEAP program is to examine the existing energy situation at each site where an EEAP study is performed. There are several reasons this effort is included. One of the prime motivations is the Army Facilities Energy Plan objective to reduce energy usage by 20% by the year FY85 in comparison to a base year of FY75. In an EEAP study, one of the objectives is to identify the base year (FY75) consumption and compare the current energy situation to that value. Based on this comparison, some judgement can be made as to additional effort required in terms of new construction projects to allow reductions to meet the goal.

In addition to comparison with the FY85 energy goal, examination of the existing energy situation can provide an indication of the relative importance of each type or component of energy consumption. By comparing how much energy is used for heating vs. the consumption for domestic water heating for example, the study may establish priorities for those items which have the greatest potential for energy savings. One difficulty which arises in performing this type of analysis is the general lack of sub-metering data of a particular installation's energy consumption. Since most Army facilities were constructed during a time when energy costs were relatively unimportant, very little emphasis in the past has been placed on actual metering of energy usage for a particular function. For example, it's impossible in most cases to examine actual metered data of individual building's energy consumption within a facility or the usage of energy for different activities within a building. Since this

metered data is not available, engineering estimates have to be made to determine the data.

A third objective in examining the existing energy situation at a facility is to provide an overview prior to the detailed point by point energy conservation opportunity evaluation. Because the detailed analysis is so voluminous, it's easy to lose track of the objective of the EEAP program.

2.2 General Description:

All Kreuzberg Kaserne utilizes electricity purchased from the local electric utility. The utility company then bills the U.S. Army for the energy consumed at each installation. The price of electricity is composed of charges for kilowatt - hour (KWH) and kilowatt (KW) demand.

Electricity is utilized for a variety of tasks including lighting, operation of heating system distribution equipment, and office and household equipment. Data processing and communications equipment with its associated mechanical coding systems also consume electricity.

Fossil fuels including coal, number 2 oil, and natural gas are consumed to provide space heating, domestic hot water and process steam. While space heating accounts for the major fraction of fossil fuel energy consumed at most installations, housing areas, troop billets, and mess halls use large quantities of domestic hot water and heat for food preparation.

2.3 Energy Consumption Components:

As discussed earlier, no detailed sub-metering data is available for the sites to provide a break down of energy consumption by component. Computer modeling and engineering estimating techniques have been used to assess constituent energy consumption.

2.4 Utility Metering:

2.4.1 Electricity:

Kreuzberg Kaserne receives electricity through and is billed from one revenue meter. Activities within the site are not billed separately and thus no advantage exists for the use or installation of additional sub meters. Some family housing units contain individual apartment electric meters, however, Army policy prohibits charging occupants with monthly utility costs. Consequently, their use can only be for evaluating the effectiveness of energy conservation programs. Additional metering as part of an electrical demand control system may be advantageous.

2.4.2 Fuels:

Records of monthly coal and fuel oil usage are recorded for each boiler plant. Natural gas is metered at each building with gas service. The installation of additional metering devices would be quite expensive and is not recommended.

2.5 Electrical Energy

2.5.1 Information on Electrical Energy Consumption in total kilowatt hours and kilowatt demand was requested for fiscal years 1981, 1982, 1983 as well as data for fiscal year 1975 which is to serve as the base for comparison of energy conservation goals. This data is contained in the PHASE I DATA REPORT and presented in both tabular and graphic forms. Refer to Section 2.7, Total Energy Consumption and Figure 2.2 for a representation of annual energy consumption.

2.5.2 The total cost of electricity is composed of charges for kilowatt-hour (KWH) con umption, kilowatt (KW) demand, and power factor correction. The price per KWH paid varies depending on the season (Summer vs. Winter) and time of usage (normal vs. off-peak). Kreuzberg does not pay for power factor correction. Charges for each component of the electric bill is included in Figure 2.1 as of Jan. '84. Also included in this figure is the average total price per KWH and electric energy cost in Deutsch Marks per million BTUs (DM/MBTU) and dollars per million BTU's ($1 MBTU).

2.6 Fuels

2.6.1 Several types of Fossil Fuels are utilized for providing space heating, domestic hot water and process steam. These include natural gas, coal and number 2 fuel oil. Consumption of heating fuels by installation are included in the PHASE I DATA REPORT. This information is presented in tabular and graphic form for each fuel for each fuel type used. Refer to Section 2.7, Total Energy Consumption and Figure 2.2 for a representation of annual energy consumption.

2.6.2 Prices for oil, natural gas, and coal were obtained from the Utilities Branch of Facilities Engineering in Zweibruecken and from the USAREUR Energy Center in Rheinau, Germany. These prices are listed below.

Number 2 Fuel Oil	=	$.5233 DM/Liter
Natural Gas	=	22.00 DM/Month, Meter Charge
		+ .570 DM/Cubic Meter,

Coal:

Anthracite	Stove	=	$115.14/Metric Ton
Anthracite	Nut	=	$112.51/Metric Ton
Anthracite	Pea	=	$ 99.52/Metric Ton
Bituminous	High Vol	=	$ 69.00/Metric Ton
	Medium	=	$ 70.87/Metric Ton

Transportation Changes = $33.70/Metric Ton, Anthracite
= $37.20 Metric Ton, Bituminous

These energy costs were converted into the units Deutsch Marks per Million BTUS (DM/MBTU) for use in the economic analysis.

To accomplish this the following energy conversion factors obtained from the ECIP Guidance Criteria dated Feb. 18, 1983 were used:

1 KWH Electricity	=	11,600 BTU
1 Gallon #2 Oil	=	138,700 BTU
1000 FT^3 Natural Gas	=	1,031,000 BTU
1 Short Ton Anthracite Coal	=	25,400,000 BTU
1 Short Ton Bituminous Coat	=	24,580,000 BTU

Using these factors and metric conversions, the following energy costs were calculated.

Anthracite (stove) Coal	= 14.885 DM/MBTU	=	$5.907/MBTU
Bituminous (medium) Coal	= 11.168 DM/MBTU	=	$4.432/MBTU
Number 2 Fuel Oil	= 14.280 DM/MBTU	=	$5.667/MBTU
Natural Gas	= 15.655 DM/MBTU	=	$6.212/MBTU

Note: MBTU = 1 MILLION BTU's = 10^6 BTU, $1.00 = 2.52 DM
Energy Savings and economic calculations were performed using these prices and data on the energy source used in each building as determined during the PHASE I survey.

2.7 Total Energy Consumption:

As part of the PHASE I Data Report, all quantities of each form of energy consumed by each facility were converted to BTUs, presented graphically in the figures of Section 7 of the Data Report. Graphs depicting monthly energy consumption by energy type and graphs illustrating total annual energy consumption were included. These annual energy consumption graphs and an analysis of the percent change in energy consumption for each form of energy used in fiscal years 1975, 1980, 1981, 1982, and 1983 are reproduced in Figures 2.2 and 2.3. In creating these graphs of total energy consumption in BTUs, the energy conversion factors from the ECIP Guidance Criteria listed above were used.

2.8 Energy Consumption Analysis:

Examining these graphs and figures, several trends become evident. At most Kreuzberg, the consumption of electricity and fuels peak during the winter months. These peaks suggest that heating and its associated auxiliary loads are a major energy use and a prime target for energy conservation efforts. During the summer months, fuels are used for domestic hot water heating and process loads. With mechanical cooling used in only a small number of

buildings, summer electrical use is generally composed of a base load of lights and equipment.

The general trend from fiscal year 1975 to present shows an increase in consumption of electrical energy. This increase is due in part to a growing community population and to the increase in use of equipment including data processing centers and office appliances. Fuel consumption has declined due to community energy conservation efforts.

While it is impossible to accurately predict future fuel costs, a 7% fuel discount rate is used in the ECIP economic analysis procedure. This results in a 22.5% increase in fuel cost at the end of a 3 year period.

2.9 Summary:

Through the examination of historic energy consumption data, it is evident that space heating and its associated auxiliary loads are the major energy user. Energy conservation efforts directed at reducing heat loss through building envelope modification and improving heating system efficiency offer great potential for savings as illustrated in this report. Other key areas for energy conservation include the reduction of heating plant usage during summer months by reducing domestic hot water loads and trimming electrical consumption by improving component efficiencies and equipment control.

FIGURE 2.1

LIGHTING AND MISCELLANEOUS ELECTRICAL

ECO CALCULATIONS

BILLING RATES

GY 702 Kreuzberg Kaserne

Electrical Consumption:

Electrical consumption charges are billed at the following rates:

	Summer	Winter
Normal rate	.1211 DM/kWh	.1311 DM/kWh
Off-peak rate	.0775 DM/kWh	.0789 DM/kWh

Family Housing is the largest off-peak consumer. However, it is estimated from billing records that forty percent of this area's power is consumed during normal rate hours. Therefore, the average kWh consumption charge for the Family Housing area is approximately:

.0974 DM/kWh = 8.399 DM/MBTU - $3.333/MBTU

The Administration area operates almost entirely during normal rate hours. Therefore, the average kWh consumption charge for this area is approximately:

.1261 DM/kWh = 10.871 DM/MBTU - $4.314/MBTU

Electrical Demand:

Electrical Peak Demand charges are billed at the following rates:

First 300 kw	-	276.82 DM/kW
Next 700 kW	-	207.62 DM/kW
Next 2000 kW	-	184.55 DM/kW

Therefore, every kilowatt of energy saved (for a load operated continually during peak hours) not only reduces the kWh consumption charge but also the peak demand charge. With a peak demand in the range of 2100 kW, each kilowatt reduction saves:

184.55 DM/yr. = $73.23/Yr.

Note: 1 KWH = 11,600 BTU
$1.00 = 2.52 DM

ELECTRICITY

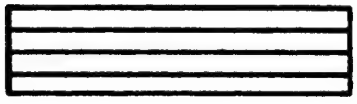
1 KWH : 11,600 BTU

#2 FUEL OIL

1 Gallon : 138,700 BTU

#6 FUEL OIL

1 Gallon : 150,00 BTU



NATURAL GAS

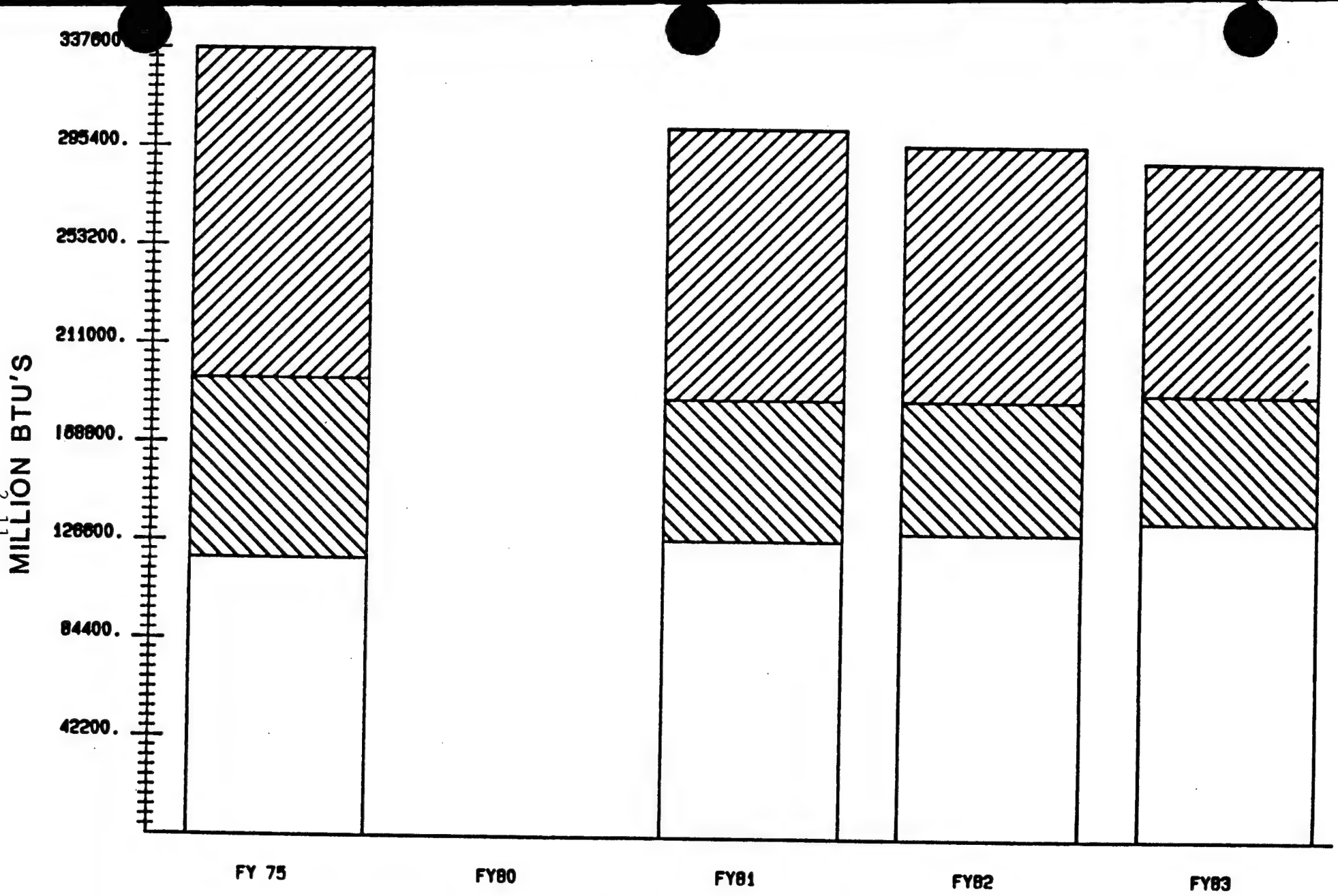
1 Cubic Meter : 36,410 BTU

COAL

1 Metric Ton (anth.) : 27,998,420 BTU

1 Metric Ton (bit.) : 27,094,534 BTU

LEGEND - ENERGY CONSUMPTION GRAPHS



KREUZBERG KASERNE GY-702 TOTAL ENERGY CONSUMPTION,

FIGURE 2.2

Refer to Legend for Energy Type and BTU Equivalency

GY AREA	FUEL	% CHANGE				
		75-80	80-81	81-82	82-83	81-83
KREUZBERG KASERNE GY-702	ELECTRICITY	--	--	2.8	4.1	14.7
	#2 FUEL OIL	--	--	-6.0	-3.5	-79.9
	COAL	--	--	-5.8	-8.9	-29.7
	TOTAL	--	--	-2.33	-2.14	-13.8

PER CENT CHANGE OF ENERGY CONSUMPTION

FIGURE 2.3

3.0 ENERGY CONSERVATION OPPORTUNITY (ECO) SELECTION

3.1 Introduction:

The objective of the EEAP studies is to identify military construction projects which will reduce energy consumption at Army facilities. These construction projects generally consist of several "energy conservation opportunities" logically combined in a manner to form a construction project. Energy conservation opportunities are the individual elements of work which can be performed to save energy. For example, replacing single glazed windows with double glazed windows is an energy conservation opportunity. Adding insulation to an existing roof is another example of an energy conservation opportunity. Those two ECOs might be combined for several buildings to be implemented as part of a single construction project.

3.2 ECO's Investigated:

One of the first steps in an EEAP study is to identify those energy conservation opportunities which will be analyzed as a part of the study. Once those items are identified, their applicability to a particular site or a particular building must be determined through judgement based on the field survey data included in the data report. The Army Facilities Energy Plan provides several lists of ECOs which have been successful at Army facilities.

An excerpt of this list was included in the Schedule of Title I Services for this project and includes those projects proven to be effective at Army Facilities in Europe. See Table 3.1. These ECO's were examined for their applicability to the Community's buildings and with minor exceptions and additions of the other ECO's

identified during the Field Survey, compose the master list of opportunities examined. Refer to Table 3.2.

Specific exclusions of items from the USAREUR ECO list include the following:

- Connect to district heating - Field Survey investigations revealed that no sources of district heat were available at any installation.

- Generate domestic hot water with heat pumps. The demand for domestic hot water during summer months when heat pumps are most effective is either too large in the case of family housing units or too small to make heat pump units economically attractive.

- Employ spot heaters - In most installations using unit heaters, activities are performed throughout the space making spot heaters impractical.

- Individual metering of family housing units - As described in Section 2.5.1, because Army regulations prohibit charging occupants for utility costs, little benefit can be realized. Some family housing units presently have individual meters but no programs for their use have been implemented.

In preparing the master list, ECO's were grouped according to "trade" into Architectural, Mechanical, and Electrical divisions.

Tables indicating which ECO's were to be investigated in the Phase II analysis for each building were prepared. These tables were submitted to the Community for review during Phase II Simultaneously, a current list of planned and funded projects was obtained from the community.

Those projects which have already received funding are not to be analyzed. Unfunded projects generated by the Community including those in the design process are to be treated as non-existent and full analysis under Phase II was performed.

One ECO often studied for large military bases is installation of a Base-wide type EMCS. Such a system is not applicable for the Zweibruecken Community. Our analysis includes only Kreuzberg Kaserne. This installation is currently performing demand limiting manually, a function that could easily be performed by an EMCS.

TABLE 3.1 USAEUR ECO'S

1. Zone existing multiple use facilities to reduce energy consumption in minimal use areas.

2. Reschedule utilization for existing facilities.

3. Consolidate services into permanent buildings through alteration or new construction.

4. Connect to district heating in order to purchase or sell energy.

5. Inter connect existing power plants.

6. Consolidate existing power plants where forecastable non-recurring maintenance cost can be demonstrated.

7. Convert to more energy efficient fuels.

8. Improve existing power plant efficiency through the installation of flue gas dampers, turbulators in fire tube boilers and oxygen trim control.

9. Insulate existing supply and return piping.

10. Return condensate.

11. Convert existing energy distribution systems to utilize more efficient medium.

12. Recover heat from processes such as boiler blowdown, refrigerant gas, exhaust air from laundries and messhalls, destratification of air.

13. Supplement the generation of domestic hot water through installation of a heat pump.

14. Decentralize domestic hot water heaters.

15. Curtail availability of energy to domestic hot water heaters.

16. Reduce domestic hot water temperature.

17. Insulate existing domestic hot water storage tanks.

18. Install shower flow restrictors.

19. Improve street lighting efficiency be delamping (reduction of lighting level) or replacement with low or high pressure sodium.

20. Relamp with fluorescent, H.P. sodium or other more energy efficient lighting.

21. Control light levels automatically.

22. Utilize photocell switches.

23. Replace incandescent lamps with fluorescent or H.P. sodium.

24. Replace mercury vapor with high pressure sodium.

25. Utilize high efficiency ballasts.

26. Employ spot heating in lieu of existing unit heaters.

27. Individual vs. stairwell or area metering of military family housing.

28. Recommend preventive maintenance program procedures for high efficiency motor replacement.

29. Provide or improve existing controls such as thermostatic radiator valves, outside air reset, night setback, duty cycling and economizer cycles.

30. Insulate basement ceilings, walls, attic floors and roofs.

31. Install caulking and weather stripping.

32. Install storm or energy efficient windows, double glaze existing windows, reduce window area, install translucent panels, upgrade by replacement, install thermal barriers, modify sky lights.

33. Replace existing doors, install vestibules, air curtains and load dock seals.

34. Study the feasibility of peak demand shedding.

TABLE 3.2

MASTER LIST OF ECO's

ARCHITECTURAL

INSULATE ROOF OR CEILING

INSTALL DOUBLE GLAZED WINDOWS

INSTALL STORM WINDOWS OVER EXISTING WINDOWS

WEATHERSTRIP DOORS

WEATHERSTRIP WINDOWS

CAULK WINDOWS

REPLACE LOADING DOORS

INSTALL VESTIBULE

INSTALL DOOR CLOSERS

INSTALL THERMAL CURTAINS

REDUCE GLASS AREA

RESCHEDULE UTILIZATION OF EXISTING FACILITY

TABLE 3.2

MASTER LIST OF ECO's

MECHANICAL

RADIATOR VALVES

CONVERT TO HW HEAT

ADJUST CONTROLS

SPACE TEMP FEEDBACK

TIME/THERMOSTAT UNIT CONTROL

EXHAUST HOOD OUTSIDE AIR SUPPLY

REPAIR/REPLACE DAMPERS

INSULATE PIPE/EQUIPMENT

FLOW RESTRICTORS

REDUCE DHW TEMPERATURE

SUMMER WATER HEATER

DISCONTINUE DOMESTIC HOT WATER

LOCAL BOOSTER HEATER

CONVERT TO CENTRAL BOILER PLANT

REDUCE AIR STRATIFICATION

TABLE 3.2

MASTER LIST OF ECO's

MECHANICAL (con't.)

UPGRADE BOILER CONTROLS

INSTALL ECONOMIZER CONTROLS

REZONE BUILDING HEATING

INSTALL WASTE HEAT RECOVERY SYSTEMS

TABLE 3.2

MASTER LIST OF ECO's

ELECTRICAL

USE HIGHER EFFICIENCY
FLUORESCENT LAMPS

USE HIGHER EFFICIENCY
LAMPS & BALLASTS

USE HIGHER EFFICIENCY
FLUORESCENT FIXTURES

REPLACE EXISTING LENSES
WITH HIGHER EFFICIENCY TYPE

REPLACE INCANDESCENT FIXTURES
WITH FLUORESCENT

ADD SWITCHES TO TURN OFF LIGHTS
NOT IN USE

INSTALL TIMERS FOR LIGHTS IN STAIRS
AND CORRIDORS

REDUCE ILLUMINATION TO ARMY
GUIDELINE LEVELS

IMPLEMENT TASK LIGHTING METHODS

DELAMP DISPLAY FIXTURES IN
RETAIL STORES

TABLE 3.2

MASTER LIST OF ECO's

ELECTRICAL (con't.)

DISCONNECT ELECTRIC WATER COOLERS

CONSOLIDATE ELECTRIC COFFEE MAKERS

TURN OFF ELECTRICAL APPLIANCES WHEN NOT IN USE

REPLACE EXISTING LIGHTING SYSTEM WITH MORE EFFICIENT SYSTEM

ADJUST OUTDOOR LIGHTING CONTROLS

4.0 PROJECT DEVELOPMENT

4.1 Introduction:

Once the ECOs were selected for each building, the next step in the EEAP process was calculation of the savings which would result from and the cost to implement each ECO in each building. The savings from various ECOs have been calculated using a combination of manual and computerized analysis techniques.

Estimated costs have been calculated based on the extent of work in each building. Unit prices used in the estimate were obtained from Lameyer International, GMBH located in Frankfurt, West Germany. Lameyer International is a mechanical consulting and contracting firm. All construction cost estimates are in Deutsch Marks and are for FY83.

This savings and cost data for each ECO was used to compute economic parameters to determine the viability of a particular project. This economic analysis has been performed in accordance with ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) GUIDANCE dated 15 February 1985, which was furnished as criteria for the revision of this EEAP study. That ECIP guidance requires the computation of a number of economic measures. These include:

1. ECO construction cost (Deutsch Marks).

2. Total annual energy savings.

3. Annual cost savings ($).

4. Total discounted cost savings ($).

5. Discounted savings/investment ratio (SIR).

6. Discounted energy savings/investment ratio (ESIR).

Having performed the economic analysis, ECO's not meeting the minimum economic criteria of savings/investment ratio (SIR) greater than 1.0 were dropped. The remaining projects were sorted and combined to form projects falling into one of three project categories.

1. ECIP Projects.

2. Community Energy Conservation Projects.

3. Increment F Projects.

This process is described in some detail in Section 6.0 of the Energy Report.

4.2 ECIP Projects:

ECO's with SIR's and ESIR's greater than 1.0 were combined according to criteria supplied by the Community to form projects meeting the minimum project cost requirement by the ECIP criteria. For family housing, projects must cost $100,000 or more. All other ECIP projects must be of at least $200,000.

At Kreuzberg Kaserne, one ECIP project was created. The project includes the insulation of the roofs of 21 buildings.

An Energy Management and Control System (EMCS) was evaluated but revisions to the ECIP criteria and fuel cost data used resulted in the project proving to be uneconomic.

A summary sheet for the ECIP project containing cost, savings and economic data is presented in Table 4.1. Additional discussion of its impact on Community Energy Consumption is contained in Section 5.0 of this Report.

4.3 Community Energy Conservation Projects:

Economically viable projects whose construction costs were less than the ECIP minimum and could not be effectively combined to reach that minimum were grouped into a separate category. These projects will be funded by the community. Project documents (Form 4283) were prepared.

For the Zweibruecken Community, a total of 10 separate projects were identified. Of these projects, 4 involve architectural modifications, 3 are mechanical projects, and 3 include electrical modifications. A list of these projects is contained in Table 4.2.

4.4 Increment F Projects:

Many ECO's studied were of little or no cost to implement and produced significant energy savings. These projects, such as fluorescent lamp replacement, reduction of domestic hot water temperature, and weatherstripping, are classified as Increment F projects. A separate Increment F report listing the projects identified and providing guidance on their implementation has been prepared. This report also includes recommendations on the purchase of new equipment and suggests additional training programs for Community maintenance personnel which emphasizes energy conservation techniques.

TABLE 4.2

COMMUNITY ENERGY CONSERVATION PROJECTS

TYPE OF WORK	PROJECT COST	ENERGY SAVINGS
ARCHITECTURAL		
Insulate Roofs - Housing	$ 34,949	665.7 MBTU/Yr
Insulate Walls - Housing	$ 8,252	325.1 MBTU/Yr
Insulate Walls	$ 54,992	590.8 MBTU/Yr
Replace Windows	$ 11,299	112.4 MBTU/Yr
MECHANICAL		
Control Modifications - Housing	$ 7,364	211.9 MBTU/Yr
Exhaust Hood Outside Air	$ 39,302	1172.8 MBTU/Yr
Control Modifications	$ 7,884	274.5 MBTU/Yr
ELECTRICAL		
Electrical Renovation	$ 11,228	274.9 MBTU/Yr
Electrical Renovation - Housing	$ 1,790	68.2 MBTU/Yr
Replace Lighting System	$ 4,181	125.0 MBTU/Yr
TOTALS	$181,241	3,821.3 MBTU/Yr

TABLE 4.1
ECIP PROJECT SUMMARY
ROOF INSULATION - 21 BUILDINGS

GY AREA	BLDG. NO.	ECO	QUANTITY	ANNUAL ENERGY SAVINGS (MBTU/ YR)	FY89 CONSTR. COST ($)	TOTAL COST W/ ENERGY CREDIT ($)	FIRST YEAR SAVINGS ($)	TOTAL DISC. SAVINGS ($)	SIR
702	4001	6" WOOL INS. IN ROOF	11760 SQ FT	456.829	22932	23012	1910	28586	1.242
702	4002	6" WOOL INS. IN ROOF	9360 SQ FT	363.599	18252	18316	1520	22752	1.242
702	4003	6" WOOL INS. IN ROOF	11816 SQ FT	459.004	23041	23122	1919	28722	1.242
702	4004	6" WOOL INS. IN ROOF	12600 SQ FT	489.460	24570	24656	2046	30628	1.242
702	4010	6" BATT INS. IN ROOF	4580 SQ FT	556.002	3801	3814	3514	65078	17.062
702	4032	6" BATT INS. IN ROOF	6572 SQ FT	112.158	5455	5474	469	7018	1.282
702	4033	6" BATT INS. IN ROOF	6240 SQ FT	106.492	5179	5197	445	6664	1.282
702	4034	6" BATT INS. IN ROOF	14400 SQ FT	302.011	11952	11994	1262	18898	1.576
702	4040	6" BATT INS. IN ROOF	2187 SQ FT	42.246	1815	1822	177	2644	1.452
702	4041	6" BATT INS. IN ROOF	7548 SQ FT	158.002	6265	6287	660	9887	1.573
702	4043	6" BATT INS. IN ROOF	7548 SQ FT	158.002	6265	6287	660	9887	1.573
702	4045	6" BATT INS. IN ROOF	7548 SQ FT	113.997	6265	6287	477	7133	1.135
702	4048	6" BATT INS. IN ROOF	7548 SQ FT	113.997	6265	6287	477	7133	1.135
702	4049	6" BATT INS. IN ROOF	7548 SQ FT	113.997	6265	6287	477	7133	1.135
702	4050	6" BATT INS. IN ROOF	7548 SQ FT	113.997	6265	6287	477	7133	1.135
702	4051	6" BATT INS. IN ROOF	7548 SQ FT	113.997	6265	6287	477	7133	1.135
702	4052	6" BATT INS. IN ROOF	7548 SQ FT	158.002	6265	6287	660	9887	1.573
702	4053	6" BATT INS. IN ROOF	7548 SQ FT	158.002	6265	6287	660	9887	1.573
702	4242	6" BATT INS. IN ROOF	2436 SQ FT	66.230	2022	2029	419	7752	3.821
702	4243	6" BATT INS. IN ROOF	4598 SQ FT	124.998	3816	3829	790	14631	3.821
702	4057	INSTALL NEW ROOF	11521 SQ FT	489.005	36752	36880	3091	57236	1.552
		TOTALS		4770.030	215970	216726	22587	365822	1.688

5.0 PROJECT IMPACT

5.1 Introduction:

The ultimate goal of the EEAP process is to conserve energy and save money. It is easy to loose sight of this goal however and get lost in the reams of paper, and millions of calculations that compose the supporting documentation of the EEAP study. In the following sections, energy savings associated with each project developed for each energy source used are compared with present energy consumption and energy consumption of the reference year FY 75.

5.2 Projected Energy Savings:

Table 5.1 summarizes energy savings for each type of energy conservation project. Energy savings are listed in MBTU's using energy equivalency conversion factors supplied in the ECIP criteria. In the interest of being concise, the total energy savings by fuel type for all Increment F projects is listed rather than listing each Increment F project separately. For more detailed discussion of energy savings for each project, refer to the Increment F report.

Results of these energy conservation projects impact on annual energy consumption is presented graphically in Figure 5.2. This figure shows total energy consumption for FY 75, FY 83 and projected energy usage after energy conservation project implementation.

Table 5.3 lists the total energy consumption in MBTU/year by installation for FY 75, FY 83, and the projected consumption after the implementation of all ECO's. Percent change in energy consumption is also tabulated.

Through the implementation of all energy savings projects recommended by the EEAP study, energy savings of 39,247 MBTU/yr or a 13.49% reduction in energy consumption as compared with FY 83 is possible. Comparing projected energy consumption after the implementation of all ECO's to the base line FY 75 energy consumption, a savings of 85,816 MBTU/yr which is equivalent to a 25.43% reduction in energy consumption results.

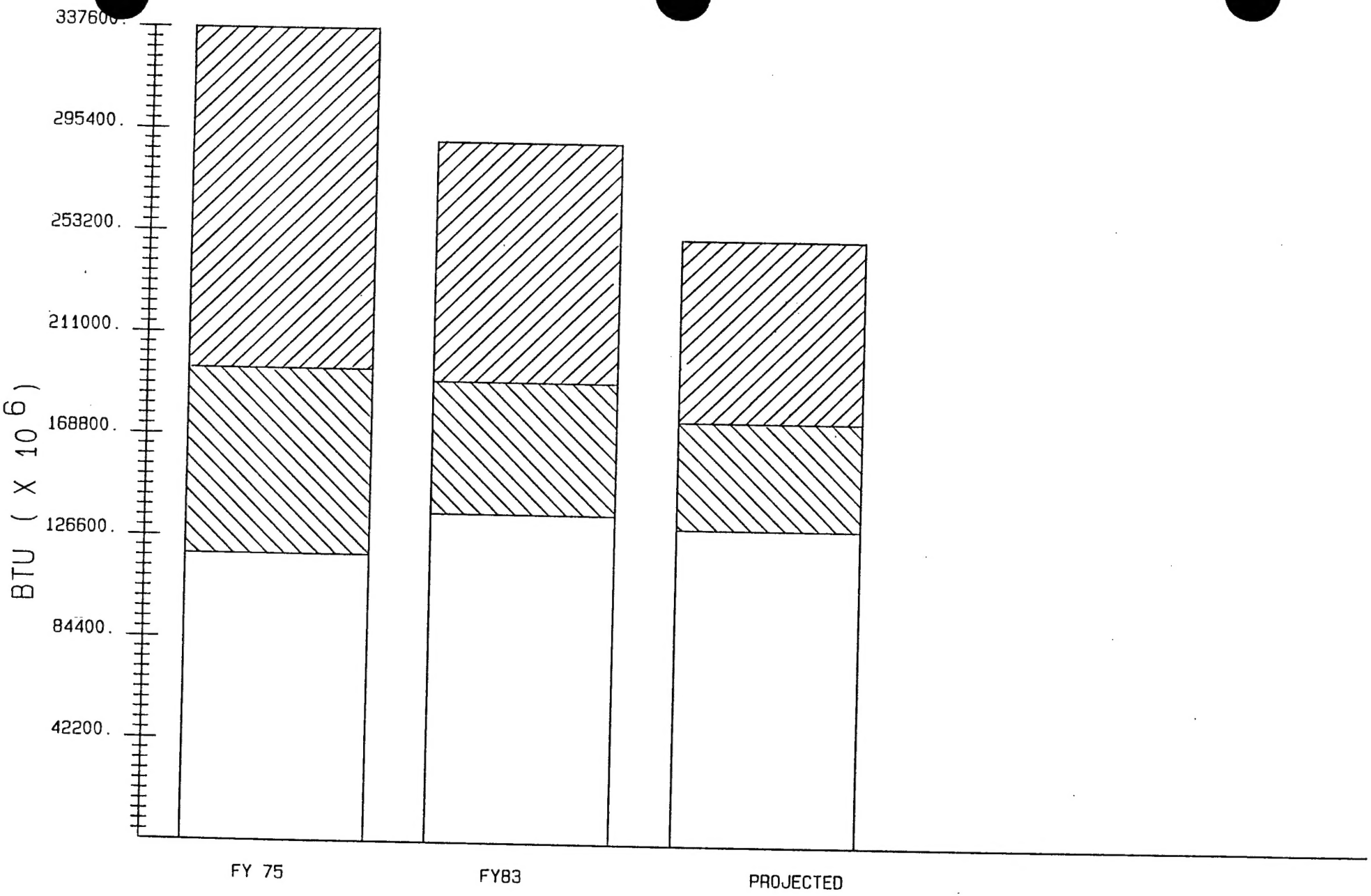
TABLE 5.1 GY 702

ENERGY CONSERVATION SUMMARY

INCREMENT F	ENERGY TYPE	SAVINGS (MBTU/YR)
Architectural	Bit. Coal	3002.2
	No. 2 Oil	984.2
	Elect.	101.7
Mechanical	Bit. Coal	4672.6
	No. 2 Oil	3309.6
	Elect.	24.6
Electrical	Elect.	2742.1
COMMUNITY CONSERVATION		
Insul. Roofs - Housing	No. 2 Oil	586.1
	Bit. Coal	79.6
Insul. Walls - Housing	No. 2 Oil	325.1
Insul. Walls	No. 2 Oil	590.8
Replace Windows	No. 2 Oil	112.4
Control Mods. - Housing	No. 2 Oil	128.8
	Bit. Coal	83.1
Exhaust Hood O.A.	No. 2 Oil	679.0
	Bit. Coal	493.9

TABLE 5.1 GY 702 (con't.)
ENERGY CONSERVATION SUMMARY

INCREMENT F	ENERGY TYPE	SAVINGS (MBTU/YR)
Control Mods.	No. 2 Oil	274.5
Electrical Renov.	Elect.	274.9
Electrical Renov. - Housing	Elect.	68.2
Replace Lighting Sys.	Elect.	125.0
ECIP		
Roof Insulation	No. 2 Oil	1236.2
	Bit. Coal	3533.8
TOTAL		
	No. 2 Oil	8,227
	Bit. Coal.	11,865
	Elect.	3,337
	Total	23,429



KREUZBERG KASERNE GY-702 TOTAL ENERGY CONSUMPTION

Refer to Legend for Energy Type and BTU Equivalency

FIGURE 5.2.

TABLE 5.3

TOTAL ENERGY CONSUMPTION (MBTU/YR)

PERCENT CHANGE

INSTALLATION	FY 75	FY 85	PROJECTED	75-85	85-PROJ	75-PROJ
GY 702	337,399	290,830	267,401	-13.80	-8.06	-20.75

TABLE 5.3

TOTAL ENERGY CONSUMPTION (MBTU/YR)

PERCENT CHANGE

INSTALLATION	FY 75	FY 85	PROJECTED	75-83	83-PROJ	75-PROJ
GY 702	337,399	290,830	251,583	-13.80	-13.49	-25.43